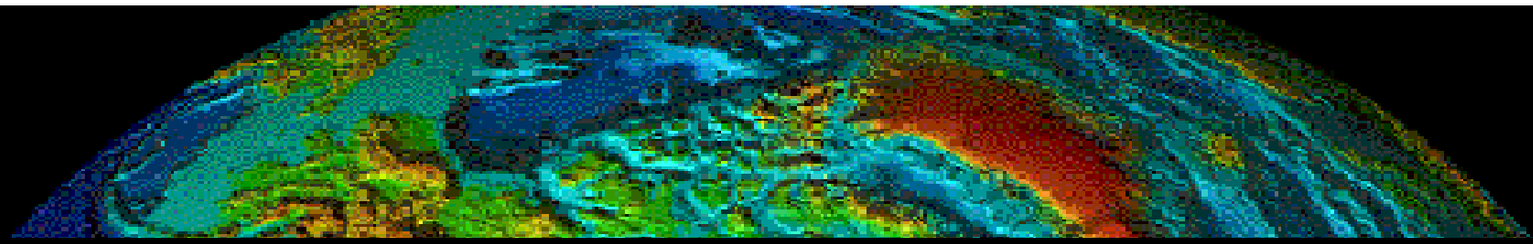
Center's Internet Web Page URL Address: http://tsc.wes.army.mil

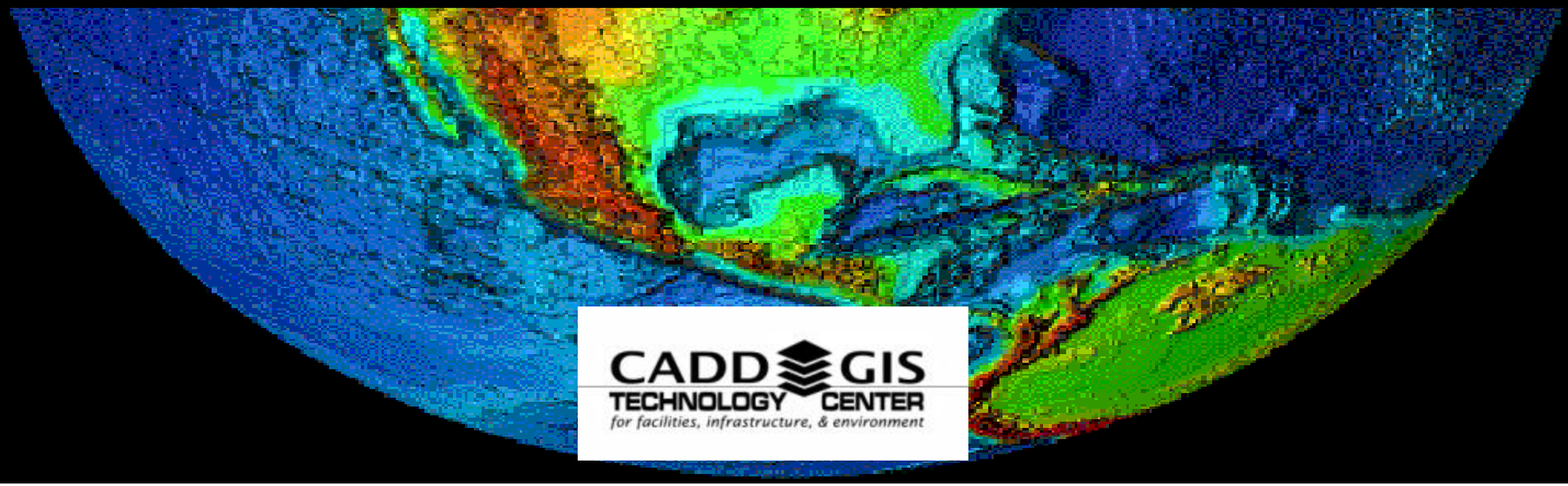


Spatial Data Standards for facilities, infrastructure, and environment (SDSFIE)

and

Facility Management Standards for facilities, infrastructure, and environment (FMSFIE)

DATA MODEL



CADD/GIS Technology Center

for facilities, infrastructure, and environment

- Originally established as the “Tri-Service CADD/GIS Technology Center” in 1992 at the Army Waterways Experiment Station, Information Technology Laboratory, Vicksburg, Mississippi .

- Established by the Army (including Army Corps of Engineers), Navy, and Air Force (i.e, Tri-Services).

- Center’s name changed to “CADD/GIS Technology Center for facilities, infrastructure, and environment” in July, 1999 to reflect a broader mission.

- CADD – Computer Aided Design & Drafting
- GIS – Geographic Information System

THE CADD/GIS TECHNOLOGY CENTER
for Facilities, Infrastructure, and Environment

About the Center

- Mission Statement

CADD

Establish a multi-agency vehicle to coordinate facilities, infrastructure and environmental use of Computer Aided Design and Drafting and Geographic Information Systems (CADD/GIS) activities within the Department of Defense (DOD) and with other participating governmental (federal, state and local) agencies, and the private sector. This includes setting standards, promoting system integration, supporting centralized acquisition, and providing assistance for the installation, training, operation, and maintenance of CADD/GIS and facilities management (FM) systems.

GIS

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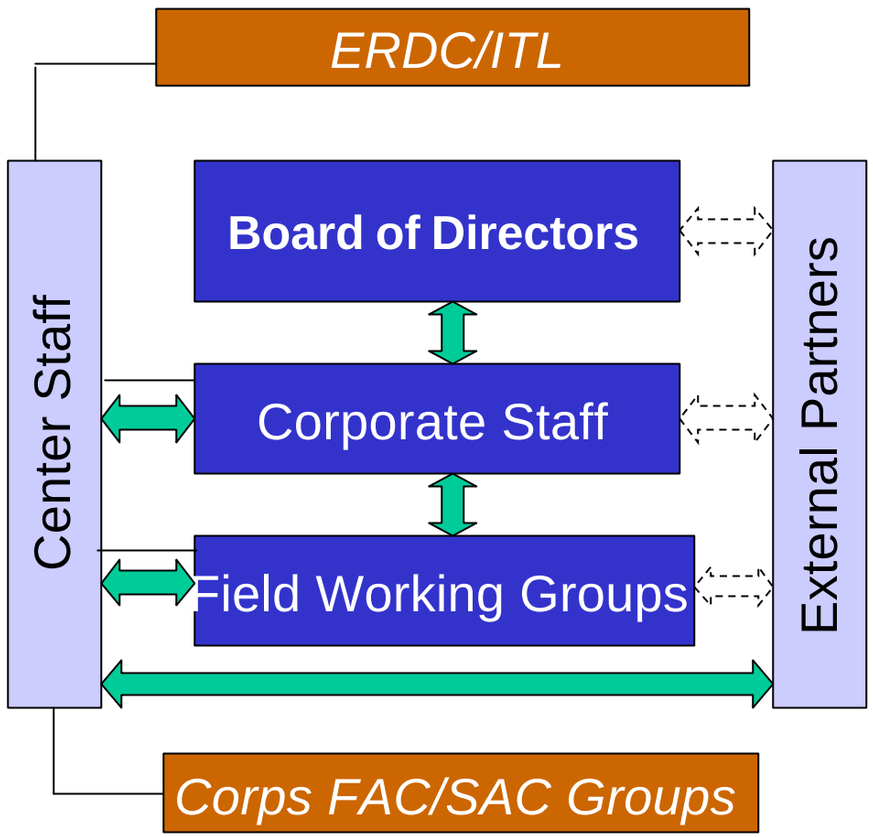
The *New* CADD/GIS Technology Center

Federal Partners:

- USACE
  - (Military Programs)
  - (Civil Works)
  - (Research and Development)
- Naval Facilities Command
- Air Force Civil Engineer
- Marine Corps
- General Services Admin.
- NASA
- Coast Guard
- Department of State
- Defense Logistics Command
- FAA

Federal Associates:

- Architect of the Capitol
- Army Reserve
- National Guard
- Veteran;s Affairs
- EPA
- Department of Interior
- DOE



Industry Associates:

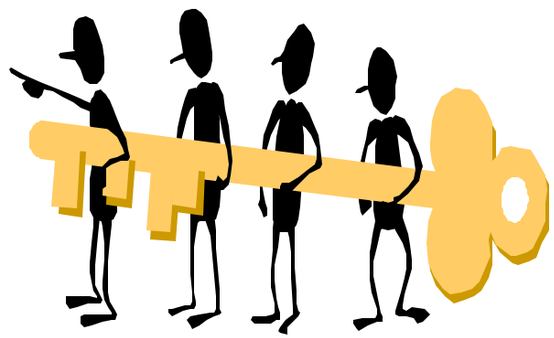
- ESRI
- Autodesk
- Bentley
- Intergaph

Societies/Organizations

- NIBS
- CSI
- AIA
- IFMA
- ISO
- ANSI
- ASTM
- ACS
- Nature Conservancy
- OGRIP
- PaMAGIC
- National Assoc.. of Counties

The Center's Approach to Standards

- **Current Efforts**
  - Architect-Engineer (A-E) Deliverables Guidelines
    - A/E/C Guidelines
    - GIS/Spatial Data Guidelines
  - Architectural/Engineering/Construction (A/E/C) CADD Standard
  - Spatial Data Standard (SDSFIE) (GIS)
  - Facility Management Standard (FMSFIE) (GIS & CADD)
  - Electronic Bid Solicitations (EBS)
  - CADD & GIS Object Standards



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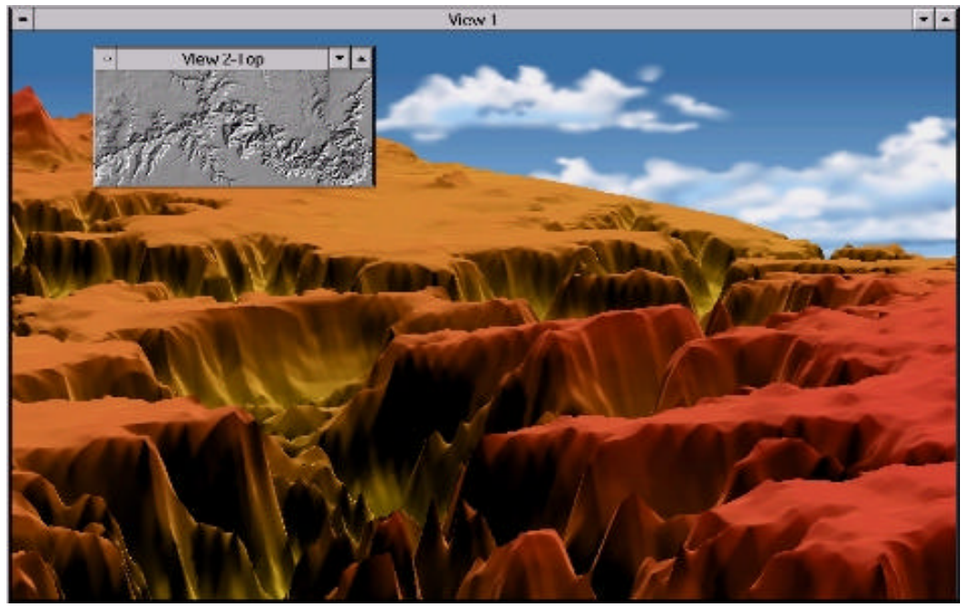
What is *GIS* ?!?!?

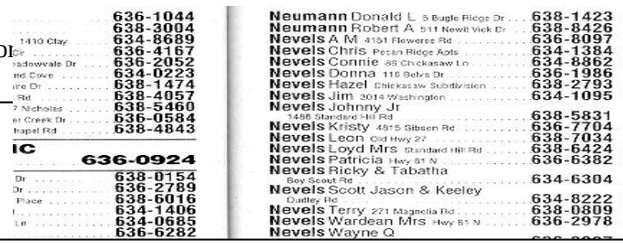


Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:

Grid_Coordinate_System:
Grid_Coordinate_System: State Plane Coordinate System 1927
State_Plane_Coordinate_System:
SPCS_Zone_Identifier: 1001
Transverse_Mercator:
Longitude_of_Central_Meridian: -082.166666
Latitude_of_Projection_Origin: +30.000000
False_Easting: 500000
False_Northing: 0.0

Planar_Coordinate_Information:

Coor



A system for capturing, storing, retrieving, analyzing, and displaying geographically referenced information, i.e. data identified according to its location on the earth.

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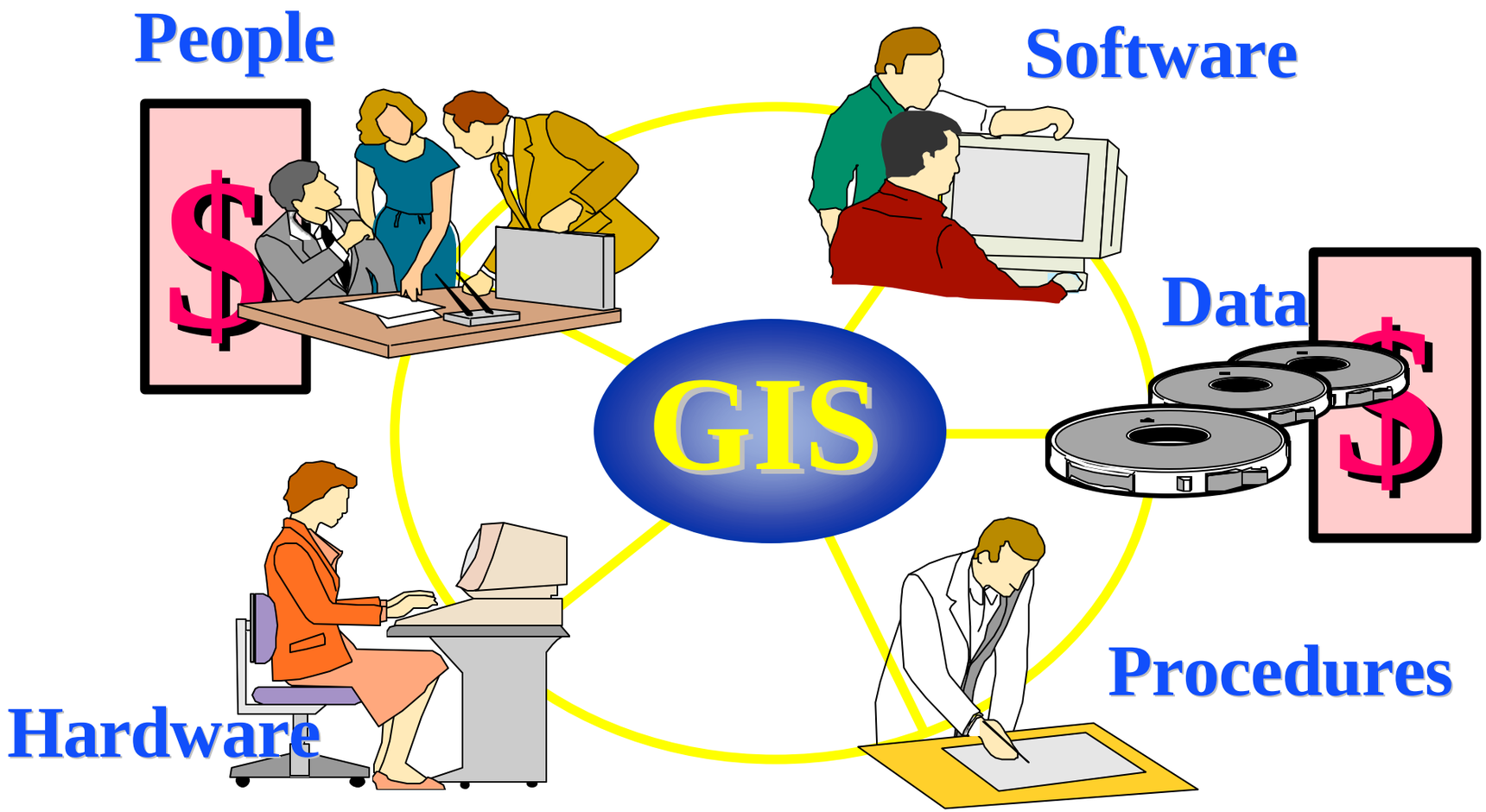
Geographic Information System



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SDSFIE & FMSFIE

Spatial Data Standard for facilities, infrastructure, & environment (SDSFIE) -

- CADD/GIS Technology Center Project No. 96.013.
- Website - http://tsc.wes.army.mil/products/TSSDS-TSFMS/tssds/html/
- Called Tri-Service Spatial Data Standards (TSSDS) prior to July 1999. Acronym SDS was used from July 1999 until January 2001. Acronym changed to SDSFIE in January 2001.

Facility Management Standard for facilities, infrastructure, & environment (FMSFIE) -

- CADD/GIS Technology Center Project No. 96.015.
- Website - http://tsc.wes.army.mil/products/tssds-tsfms/fms/fmsprods.asp
- Called Tri-Service Facility Management Standards (TSFMS) prior to July 1999. Acronym FMS was used from July 1999 until January 2001. Acronym changed to FMSFIE in January 2001.

96.013 – Spatial Data Standard (SDSFIE)

Scope: Development, improvement, and testing of Geographic Information System (GIS) Standard, called Spatial Data Standard for facilities, infrastructure, & environment (SDSFIE).

Objective: Provide a common non-proprietary data format for GIS development, thereby reducing costs and providing a vehicle for sharing GIS data sets among federal partners, commercial/private concerns, and government installations.

Products: (1) GIS data standard, (2) Interactive software tools, (3) Implementation guidance and technical reports, (4) Digital symbol sets, (5) Distribution via CD-ROM and Internet download, (6) Internet web site, (7) Workshops, and (8) Limited Customer assistance.

Spatial Data Standard (SDSFIE)

for facilities, infrastructure, &environment

- Provides a standard graphic and nongraphic (database) format and structure for GIS implementations.
- Provides a “nonproprietary” standard designed for use with commercially available “off-the-shelf” GIS and relational database software.
- Provides a GIS implementation schema for approved FGDC geospatial related data standards, and appropriate approved DISA data elements.
- Provides a grouping of geographically referenced (geospatial) features (i.e., features which can be depicted graphically on a map at their geographic location (coordinate). Each geospatial feature has an “attached” Attribute Table containing pertinent data about the geospatial feature.

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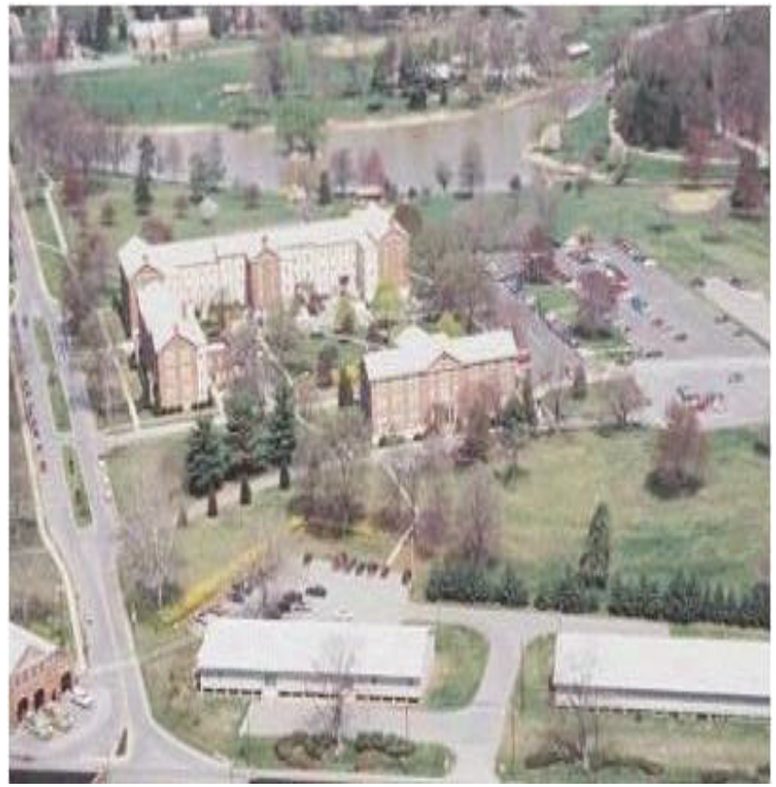
96.015 – Facility Management Standard (FMSFIE)

Scope: Development and testing of a standard for life cycle Facility Management (FM) implementations, called Facility Management Standard for facilities, infrastructure, & environment (FMSFIE).

Objective: Provide a common nonproprietary format for the collection and management of FM data thereby reducing costs and allowing for the sharing of data sets among federal partners, commercial/private concerns, and government installations.

Products: (1) FM data standard, (2) Interactive software tools, (3) Implementation guidance and technical reports, (4) distribution via CD-ROM and Internet download, (5) Internet web site, and (6) Customer assistance.



Facility Management Standard (FMSFIE)

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for facilities, infrastructure, &environment

- Provides a standard database format and structure for “business” and event data (e.g., inspections, repairs) related to SDSFIE geospatial features and/or A/E/C CADD objects, specifically for CADD/GIS Based implementations at Air Force, Army, Navy, & Marine Corps installations and Army Corps of Engineers Civil Works activities. Also provides a CADD/GIS Based FM standard for use by other Federal, State, and Local Government organizations, public utilities; and private industry.
- Provides a “nonproprietary” standard designed for use with commercially available “off-the-shelf” CADD, GIS, FM, and relational database software.
- Provides a grouping of related attribute tables containing “business and event data.
- The first FMSFIE release was included with the TSSDS/TSFMS Release 1.80, which was published on CD-ROM in February 1999.
- The FMSFIE will migrate to a Transactional Data Model in the Future. Development of the Transactional FMSFIE Data Model began in FY 2001.

Spatial Data Standard (SDSFIE) & Facility Management Standard (FMSFIE) - Development History

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- TSSDS Release 1.20 - November 1993.
- TSSDS Release 1.40 - August 1995.
- TSSDS Release 1.60 - November 1996.
- TSSDS Release 1.70 - August 1997.
- TSSDS Release 1.75 - January 1998.
- TSSDS/TSFMS Release 1.80 – February 1999.
- SDS/FMS Release 1.90 – December 1999
- SDS/FMS Release 1.95 - April 2000
- SDSFIE/FMSFIE Release 2.00 – January 2001
- SDSFIE/FMSFIE Release 2.10 – January 2002
- SDSFIE/FMSFIE Release 2.20 – August 2002

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Design Considerations

- **Must be compatible with the predominant Commercially Available CADD, GIS, & Relational Database Software.**
- GIS and CADD Software include:
  - ESRI Arc/Info - Bentley MicroStation - ESRI ArcView
  - Autodesk Map - Intergraph MGE - Autodesk AutoCAD
  - Intergraph GeoMedia - Bentley GeoGraphics - ESRI ArcGIS
- Relational Database Management System (RDBMS) Software includes:
  - ANSI Standard Structured Query Language (SQL)
  - Informix SQL - Microsoft Access - ESRI SDE
  - Oracle SQL - Microsoft SQL Server
- Operating Systems include:
  - Windows 98, 2000, NT, & XL

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DATA MODEL ORGANIZATION

- **Entity Sets**
- **Entity Classes**
- **Entity Types (Entities)**
  - SDSFIE Geospatial Features (i.e. map objects).

- **Attribute Tables**
  - Database Tables containing attributes (data about the SDSFIE Geospatial Features and FMSFIE data).
- **Domain Tables**
  - Common for SDSFIE, FMSFIE, A/E/C CADD Standards.

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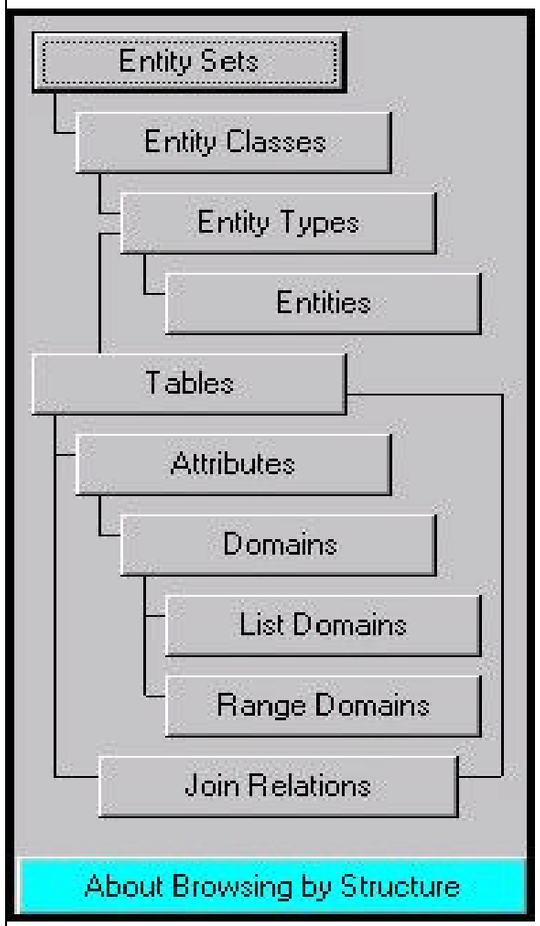
Data Model Organization

- **Entity Sets -**
    - Broad grouping for data management purposes.
- **Entity Classes -**
    - Grouping of data within each Entity Set for Data Management Purposes.
- **Entity Types -**
    - Grouping of SDS Geospatial Features (i.e., items that appear graphically on a map or drawing). Grouped within each Entity Class.
    - **Entities -**
        - Items that appear graphically on a map or drawing. Grouped within each Entity Type. Each Entity Type may have one or more Entities.
- **Attribute Tables -**
    - Relational database tables containing attribute data. Grouped within each Entity Class.
- **Domain Tables -**
    - Contains lists of “valid” or “permissible” values for specific attributes in an Attribute Table.

Data Model Schema Overview – SDSFIE / FMSFIE Release 2.200



26	Entity Sets
169	Entity Classes
967	Entity Types
6,811	Entities (CADD & CADD Based GIS)
1,055	Attribute Tables (Database Tables)
27,239	Attributes (Fields in Tables)
1,022	Domain Tables (List & Range)
22,749	List Domain Values
17	Range Domains
8,503	Relational Database Join Relationships

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SDSFIE Entity Sets

- **Entity Sets (26 Themes in Release 2.100)**

Auditory
Boundary
Buildings
Cadastre
Climate
Common
Communications
Cultural
Demographics
Environmental Hazards
Ecology
Fauna
Flora
Future Projects
Geodesy
Geology
Hydrography
Improvements
Landform
Land Status
Military Operations
Olfactory
Soil
Transportation
Utilities
Visual

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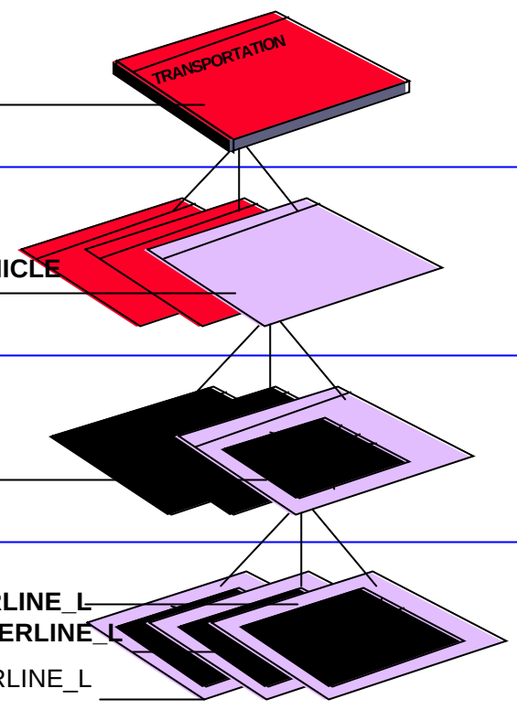
Data Model Terminology

DATA HIERARCHY	EXAMPLE DATA	GIS		CADD AM/FM	
		MGE	ARC/INFO	MicroStation	AutoCAD
ENTITY SET	TRANSPORTATION	PROJECT LEVEL	PROJECT LEVEL	PROJECT LEVEL	PROJECT LEVEL
ENTITY CLASS	TRANSPORTATION_VEHICLE	CATEGORY AND DESIGN FILE	WORKSPACE	DESIGN FILE	DRAWING FILE
ENTITY TYPE	ROAD CENTERLINE	GROUP BY FEATURES	COVERAGE FILE	GROUP BY LEVEL	GROUP BY LAYER
ENTITY	PRIMARY_ROAD_CENTERLINE_L SECONDARY_ROAD_CENTERLINE_L TERTIARY_ROAD_CENTERLINE_L	FEATURE	SELECT BY ATTRIBUTE	LEVEL	LAYER



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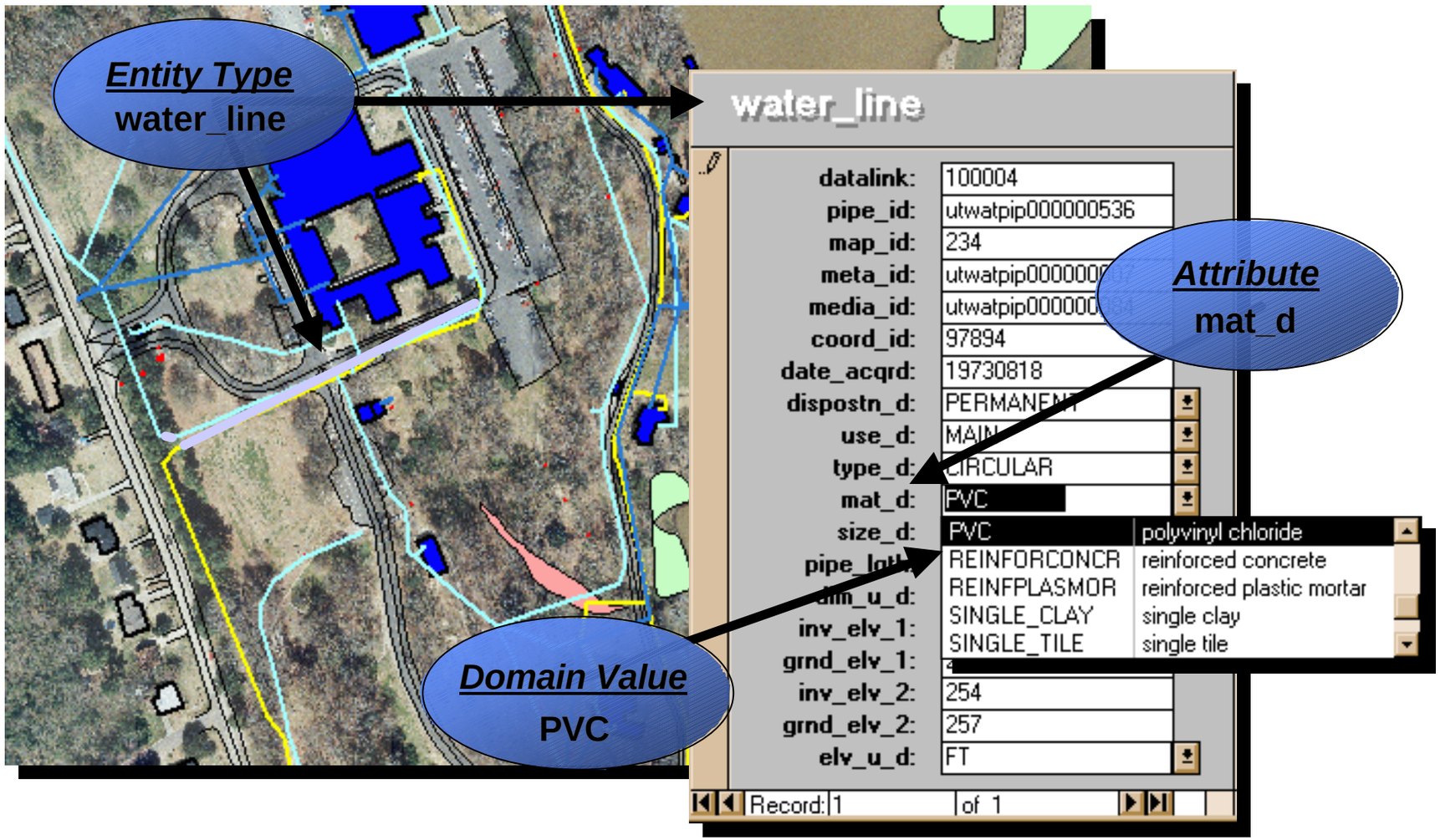
Data Model – Entity Type, Attribute Table, & Domain Value



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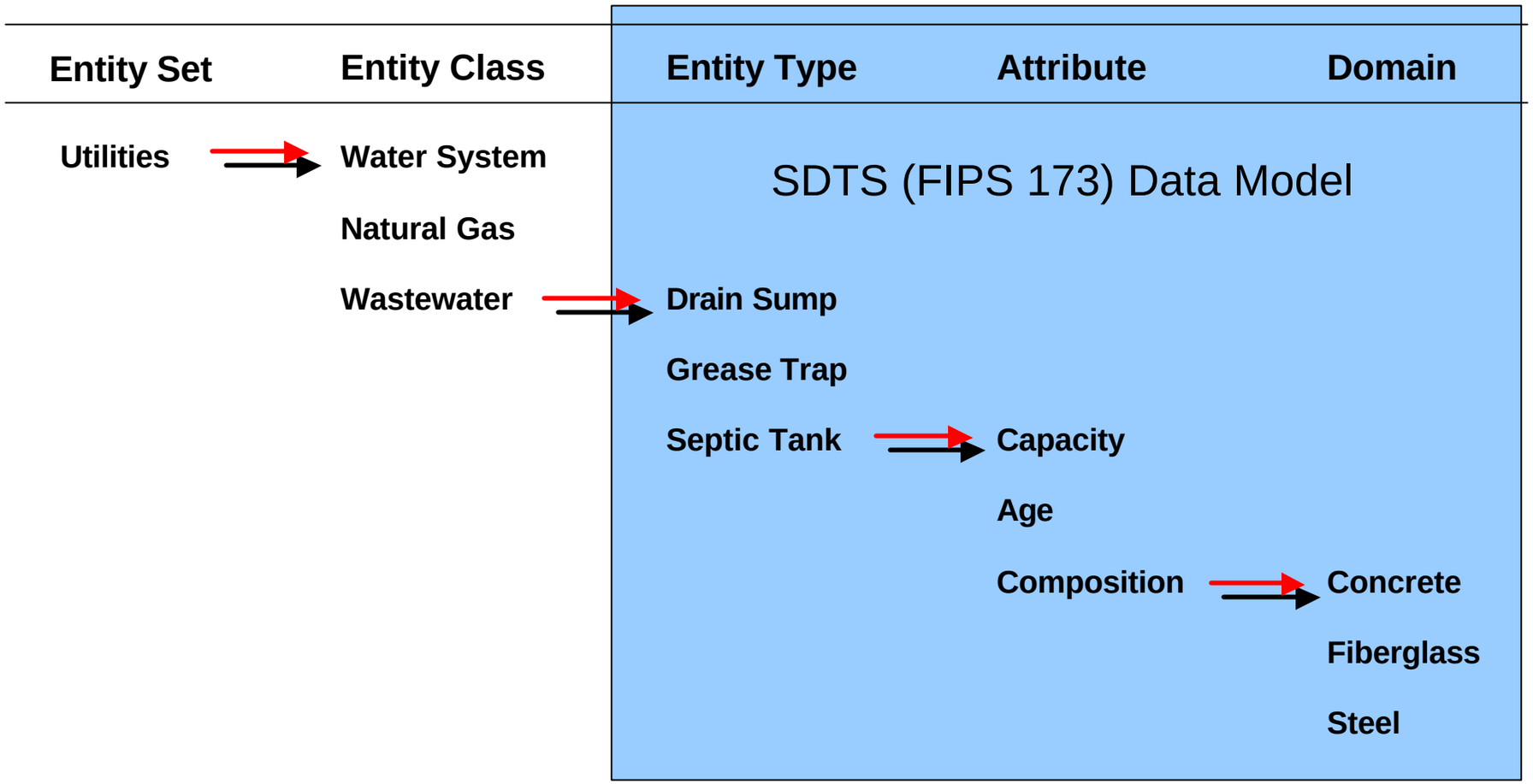
Data Model Example



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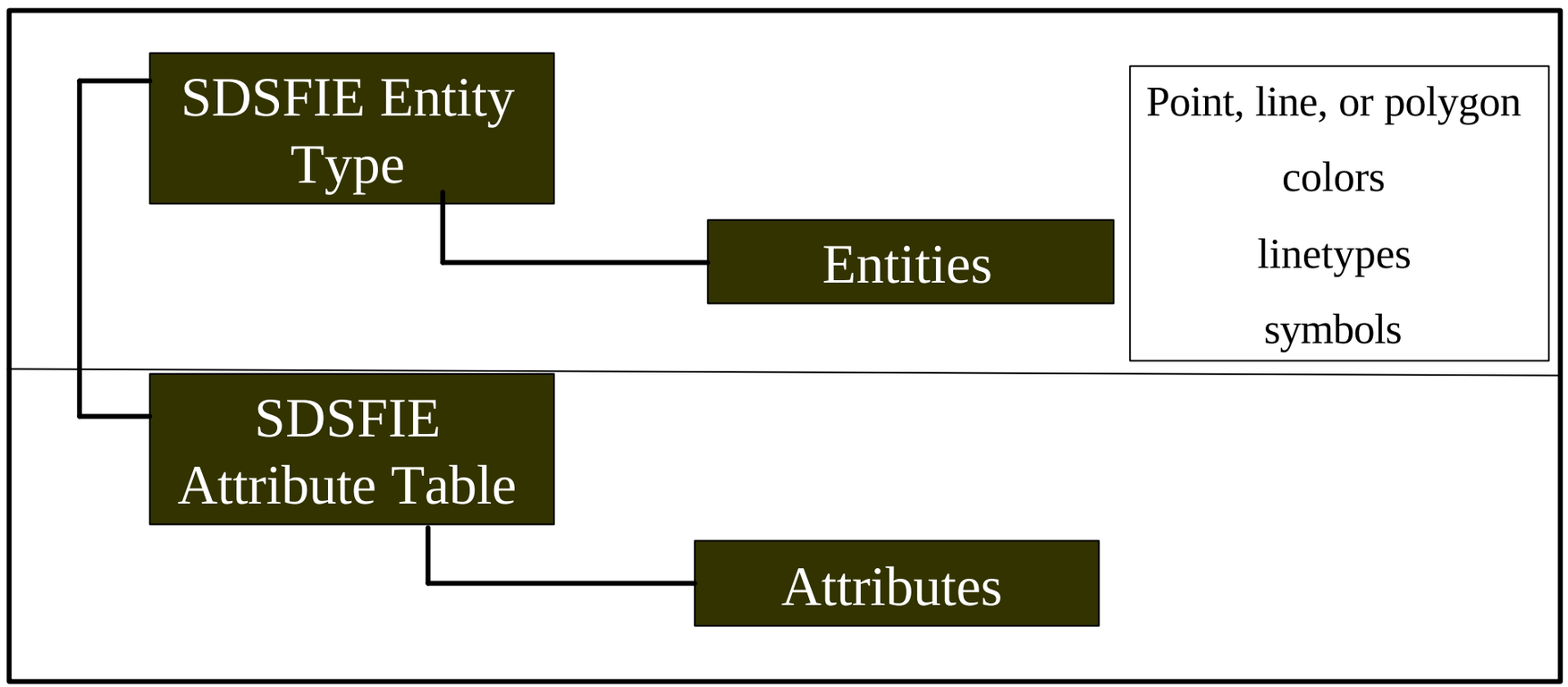
SDSFIE Entity Classes

- General logical grouping of features within an Entity Set for data management purposes.

- Each entity class will be a separate map or drawing file and corresponds to the following terms:
  - GRASS (CERL): mapset
  - MGE (Intergraph): category or design file
  - ARC/INFO (ESRI): workspace
  - MicroStation (Bentley): design file
  - AutoCAD (Autodesk): drawing file

SDSFIE Entity Classes

SDSFIE Entity Classes - Grouping of geographically referenced (geospatial) features with "attached" Attribute Tables ("graphic") within an Entity Set.



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SDSFIE Entity Classes

- Since each entity class corresponds to a map file, it can contain up 63 CADD layers (levels).
  - The SDSFIE is designed to be CADD/GIS platform independent, which means the standards are designed to work with the most limiting of the predominant commercially available CADD/GIS platforms which will be used.
  - MicroStation accepts up to 63 levels per map file.
  - AutoCAD accepts an unlimited number of layers.

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SDSFIE Entity Types

- Entity Type - The logical name of a type or object that can be graphically depicted on a map or drawing.
- Entity Types - Grouping or collection of like Items (entities) that appear graphically on a map or drawing.
- Grouped within each Entity Class.
- Each entity type has a corresponding attribute table (i.e., database table containing information concerning the entity type).

SDSFIE Entity Type Data Elements

- Items (features) which appear graphically on a map or drawing. A GIS data element can be represented as a:
  - Point - A single point representing the geographical location of a feature.
  - String/Chain - A line.
  - Boundary (G/GT Polygon) - The line string which outlines the perimeter of an area.

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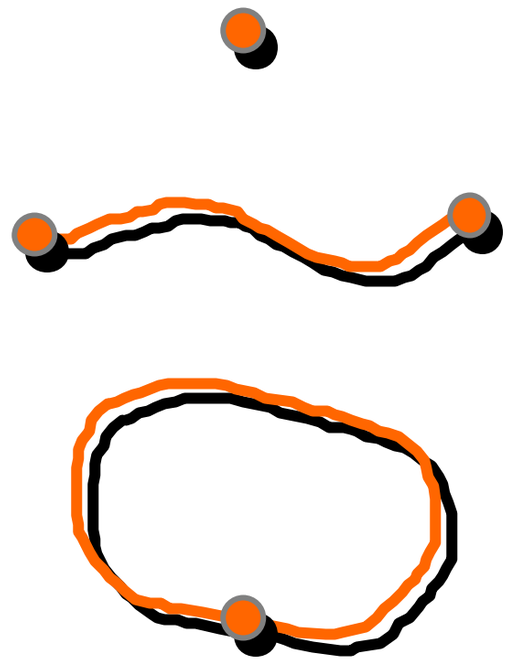
GIS Data Elements

- **Point/Node**
- **String/Chain/Line/Arc**
- **Boundary/Area/Polygon**



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SDSFIE Entities

- Entities - Applicable to CADD & CADD Based GIS.
- Representation:
  - MGE (Intergraph): A single graphic feature.
  - MicroStation (Bentley) & AutoCAD (Autodesk): on individual levels and layers, respectively.

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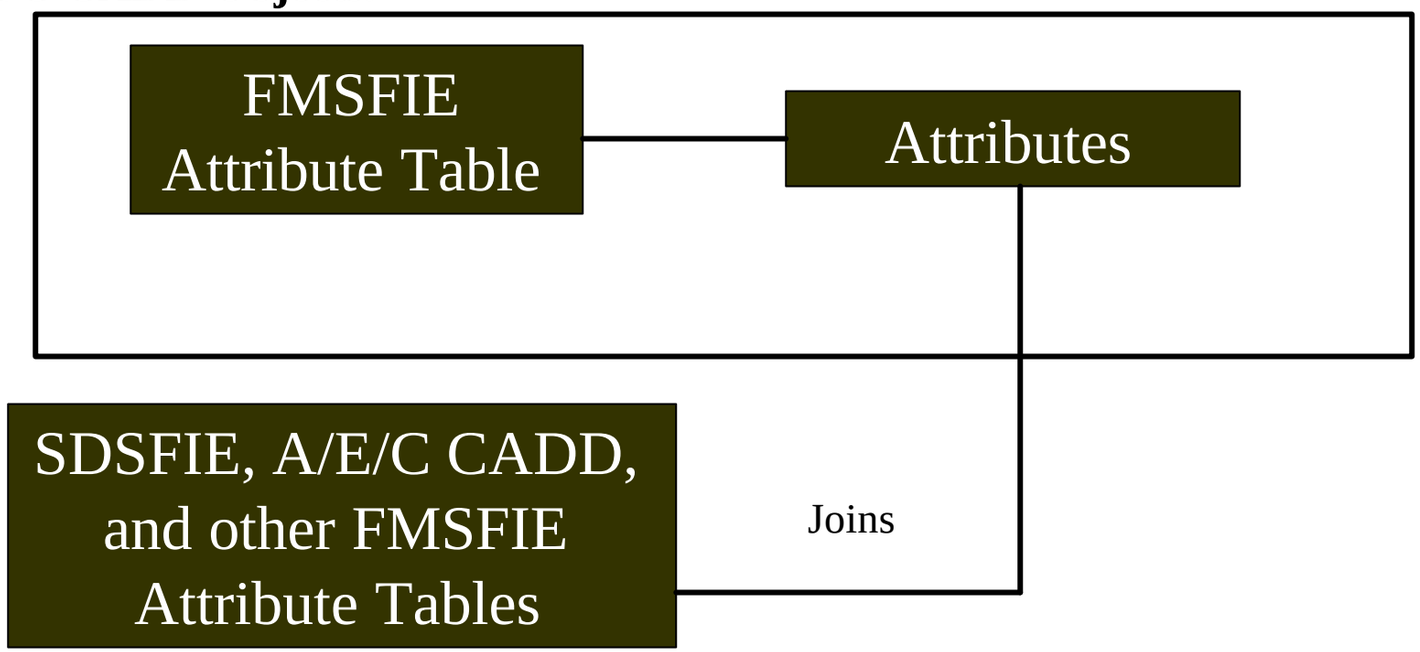
SDSFIE Entities

- The SDSFIE specifies:
  - Line styles/types for boundary and string/chain entities.
  - Level/layer assignments for all entity feature types.
  - Text size, font, and placement.
  - Colors.
  - Symbol libraries.

FMSFIE Entity Classes

FMSFIE Entity Classes (Current Data Model (2002) -

Grouping of related facility management Attribute Tables (“nongraphic”) within an Entity Set. The FM Attribute Tables provide data concerning events (e.g., inspections, repairs), and additional information, related to SDSFIE geospatial features and/or A/E/C CADD Objects.



ATTRIBUTE TABLES

- A relational database table containing non-graphic information, or attribute data.

- **SDSFIE -** A “Graphic” attribute table is linked to a graphic entity, and contains data describing the graphic entity, along with other data and relationships required for geospatial and relational analysis.

- **FMSFIE -** A “Nongraphic” attribute table contains data required for a “business process”, or function, along with data and and relationships which may be queried for geospatial and relational analysis.

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- Database - A structured collection of data items about a specific topic
  - ✓Cell - Storage unit for each data item
  - ✓Table - A group of similar records
    - Field - a "column" of related cells
    - Record - a "row" of related cells
  - ✓Key - A field with a unique identifier
    - Primary Key / Foreign Key

KEY	STUDENTS	
ID #	LAST NAME	FIRST NAME
1001	Smith	John
1074	Erickson	Colleen
1123	O'Brien	Debbie
1234	Pierce	Kevin
1399	Smith	John

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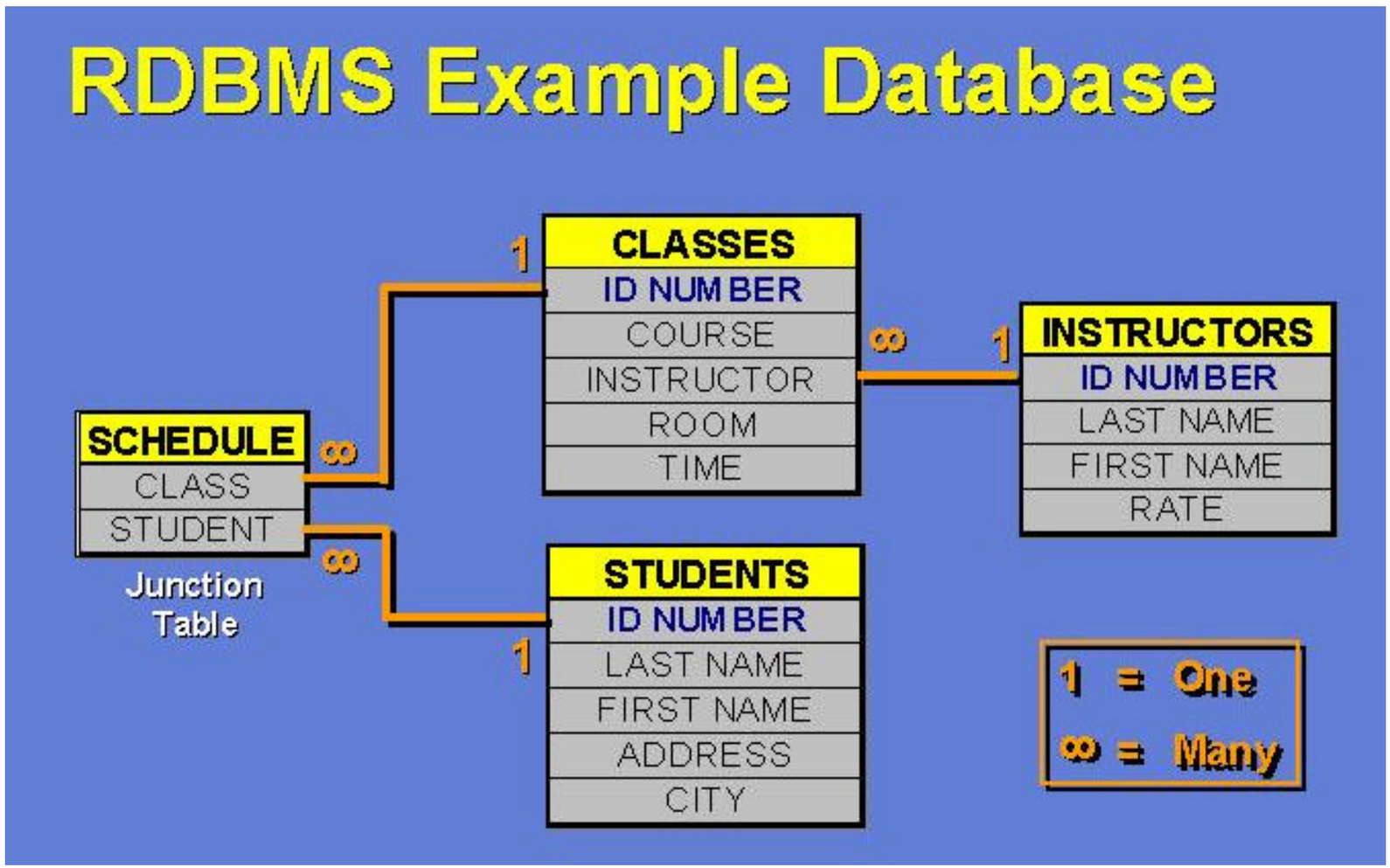

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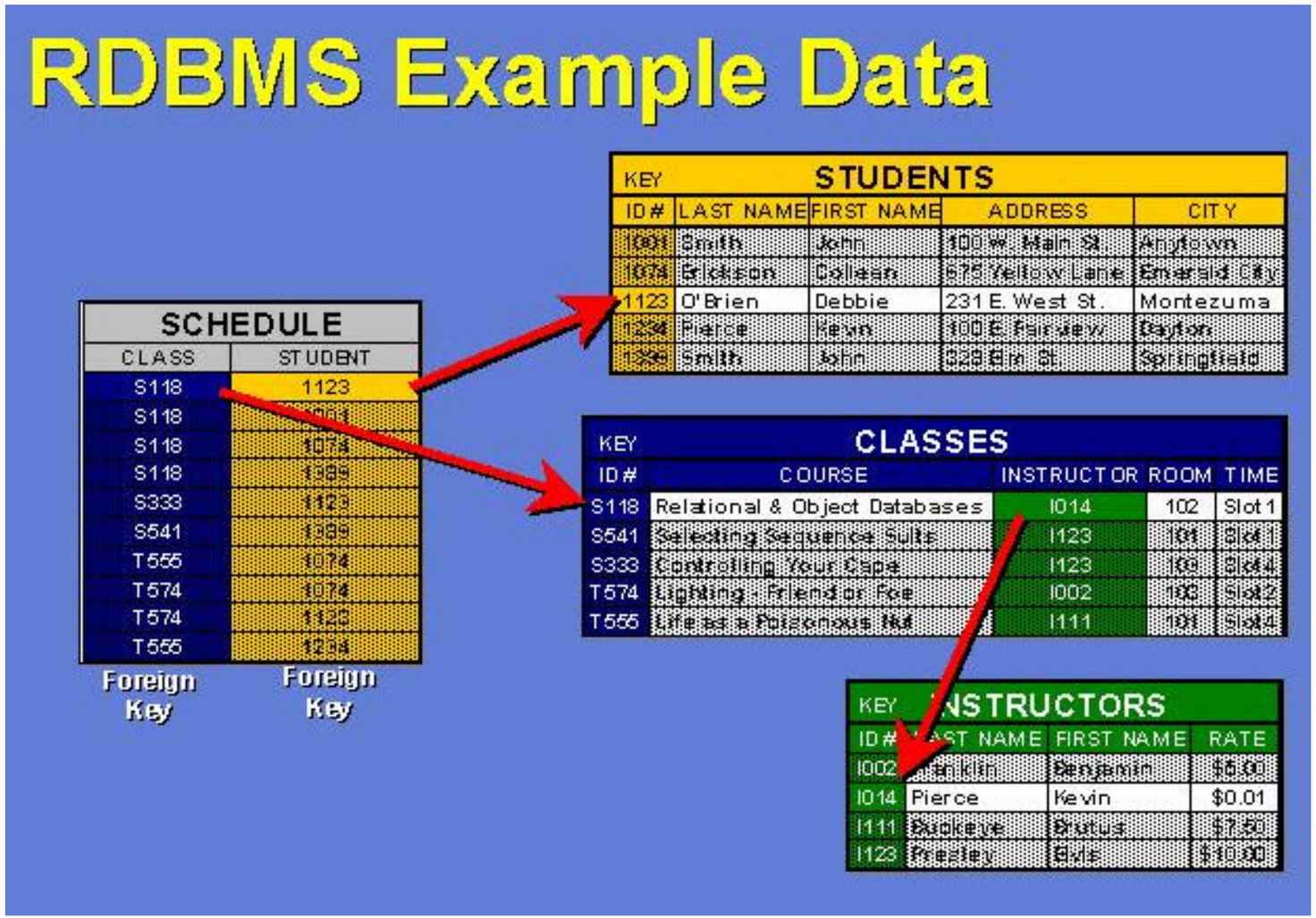

DOMAIN TABLES

- Contains lists of permissible values for specific attributes.
- Provides a finite set of “valid” or “allowable” values, and may be enlarged as necessary.
- Includes units of measure, materials, methods, dispositions, classes, status, phase, etc.

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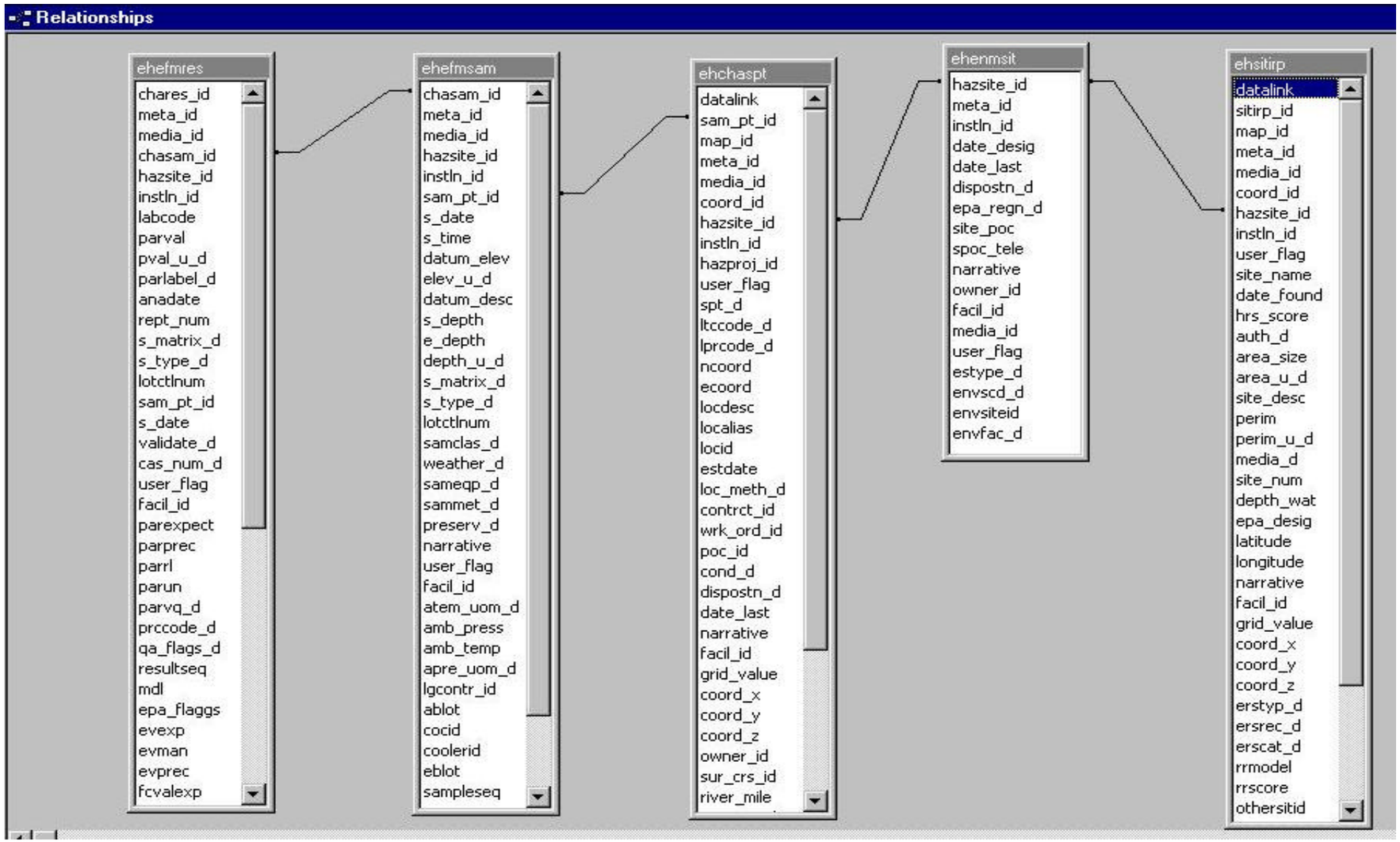
JOIN RELATIONSHIPS BETWEEN RDBMS TABLES



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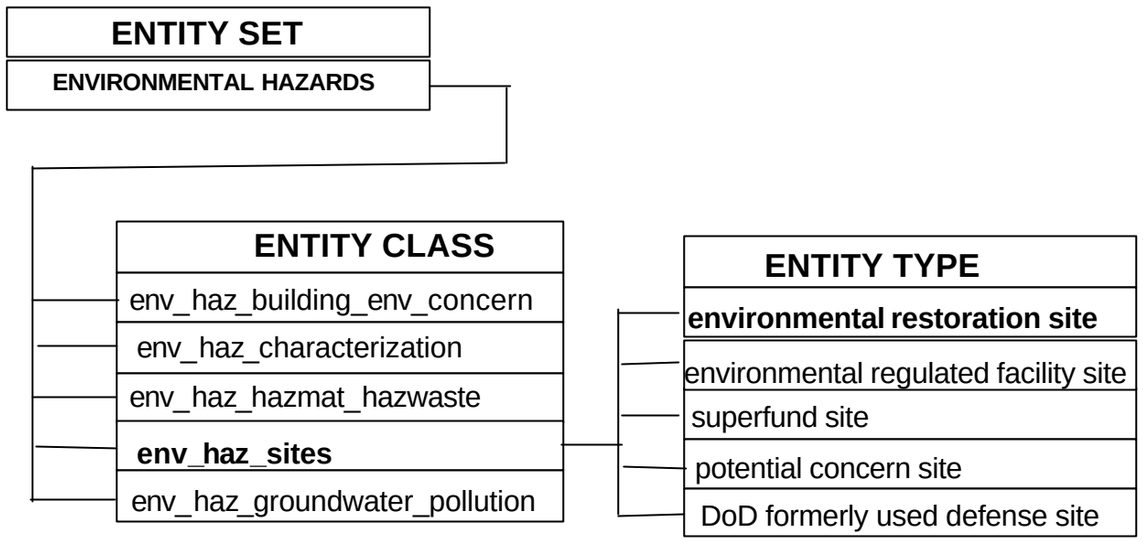
Example – Environmental Restoration Site



Environmental Restoration Site - A geographic area where an active environmental study or project is underway to remediate pollutants located in the soil, sediment, surface water, or groundwater.

Example – Environmental Restoration Site

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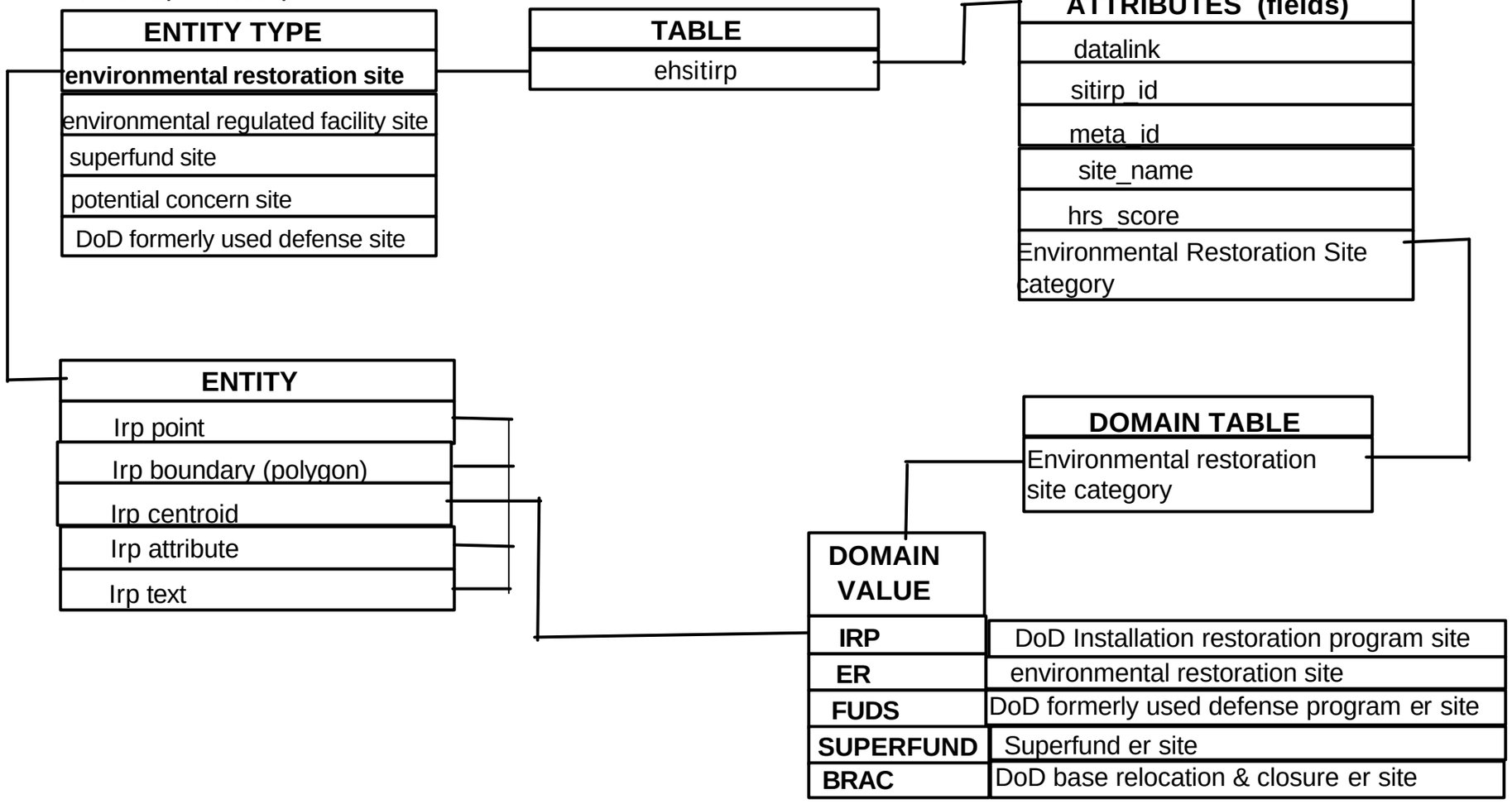
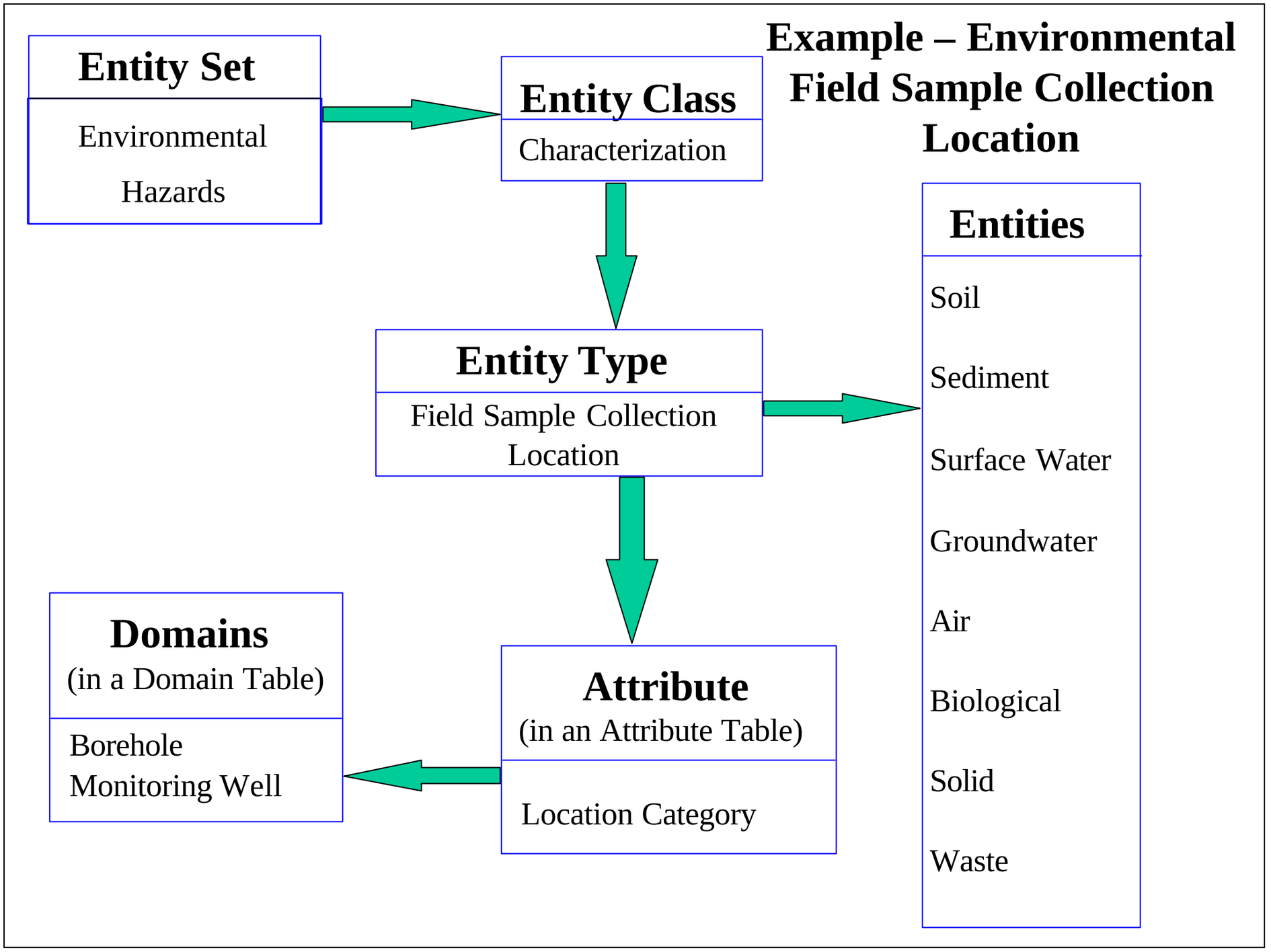


Example – Environmental Field Sample Collection Location



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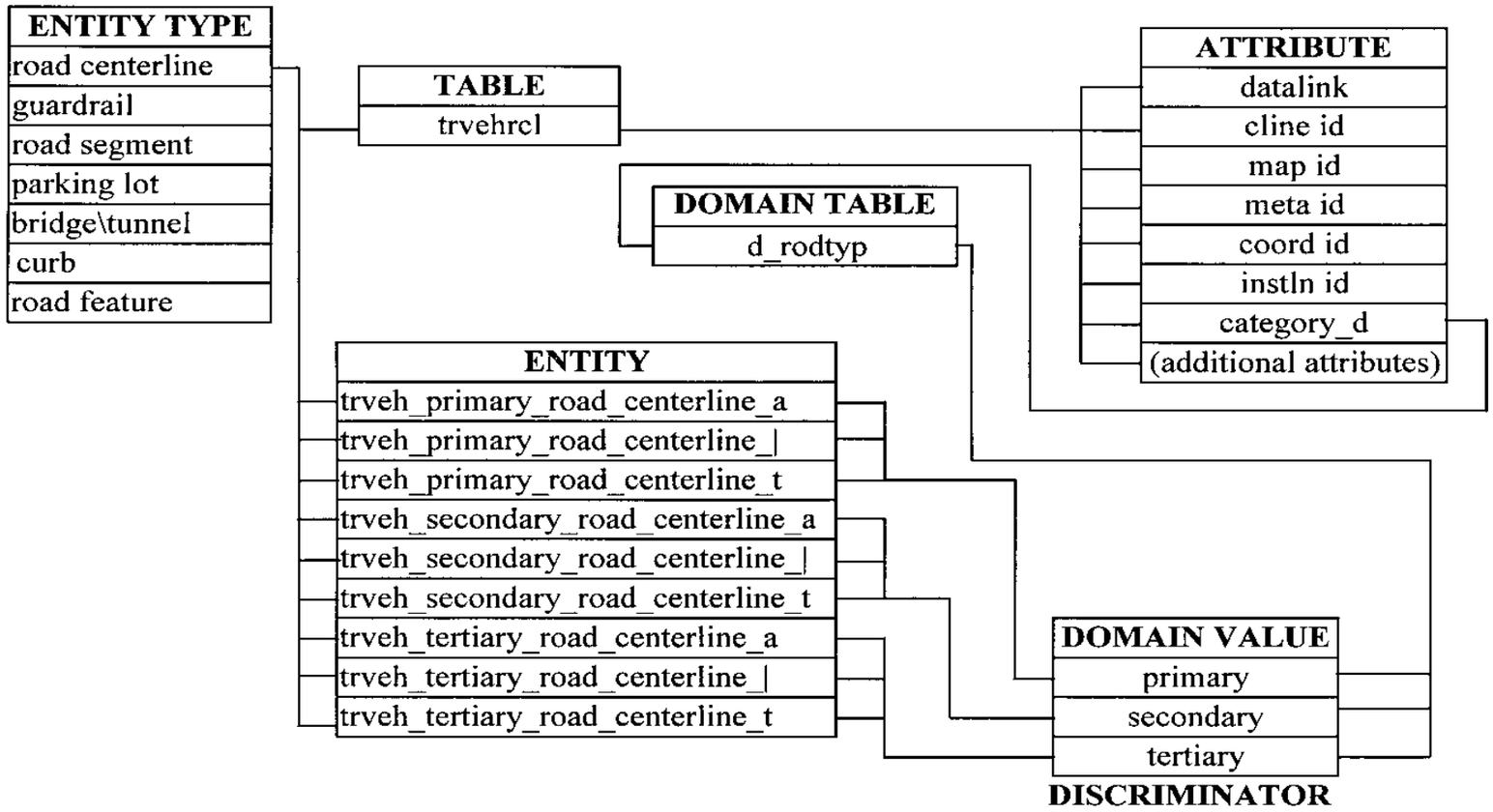
Example – Road Centerline



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GIS and Map Development Considerations

- **Accuracy of the data depends upon the source of the data (e.g., physical surveys, aerial photography, scanned drawings, GPS, etc.) and the target map plot scale. The higher the accuracy, the higher the cost of data acquisition.**

- **All CADD files (which will be used for GIS & map development) should be developed in actual (real world) size, or scale.**

- **The same origin, datum, and coordinate system should be used for all CADD files (which will be used for GIS & map development) for a specific project or installation.**

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GIS & Map Development Considerations

- **Two general categories of target map plot scales:**
  - **Small Scale Maps: Includes maps with plotted map scales of 1:62,500 or 1 inch = 5,208 feet or smaller. USGS quadrangle maps, etc.**
  - **Large Scale Maps: Includes maps or drawings with plotted map scales greater than 1 inch = 5,208 feet. Municipal, utility, master plans, base comprehensive plans, construction drawings, etc.**

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GIS & Map Development Considerations

- **Entities (i.e., features and objects) can be depicted differently at different target map plot scales.**
  - **For example, an Installation Program (IRP) Site would be depicted as a point feature (with a symbol) on a small scale map. The same IRP site would be depicted as a boundary feature on a large scale map with a scale of 1 inch = 100 feet.**

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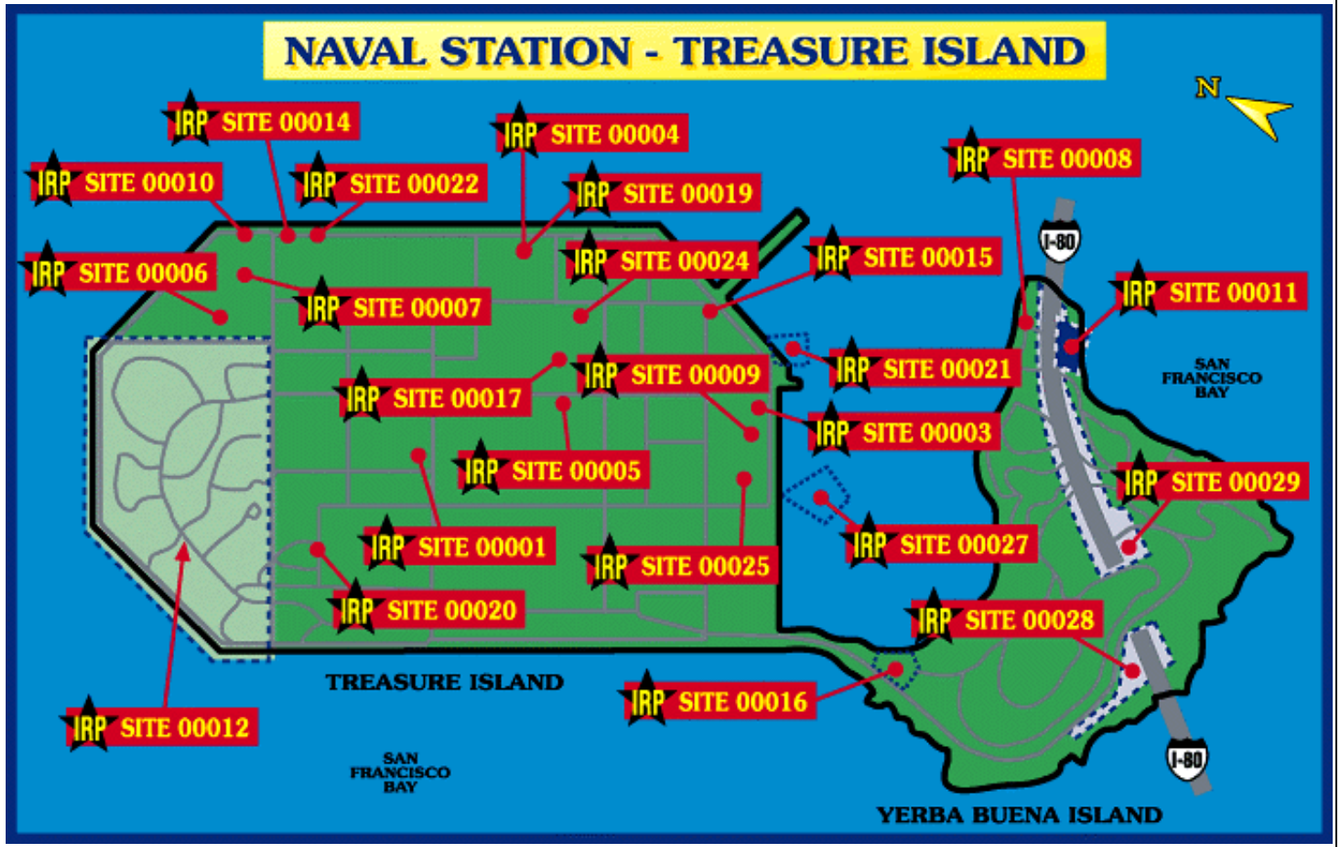
for Facilities, Infrastructure, and Environment

GIS & Map Development Considerations

DoD Installation Restoration Program (IRP) Sites are depicted as point features (with an associated symbol) on this map.
The same IRP site might be depicted as a boundary (polygon) feature on a large scale map with a scale of 1 inch = 100 feet.



THE CADD/GIS TECHNOLOGY CENTER
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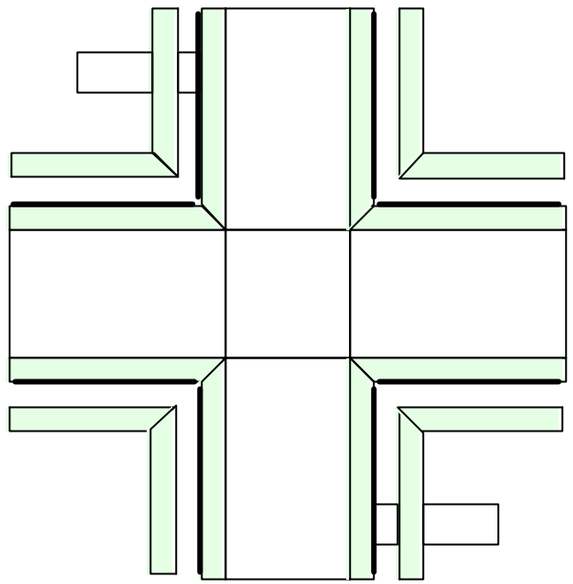
Map Plot Scale and Geospatial Data

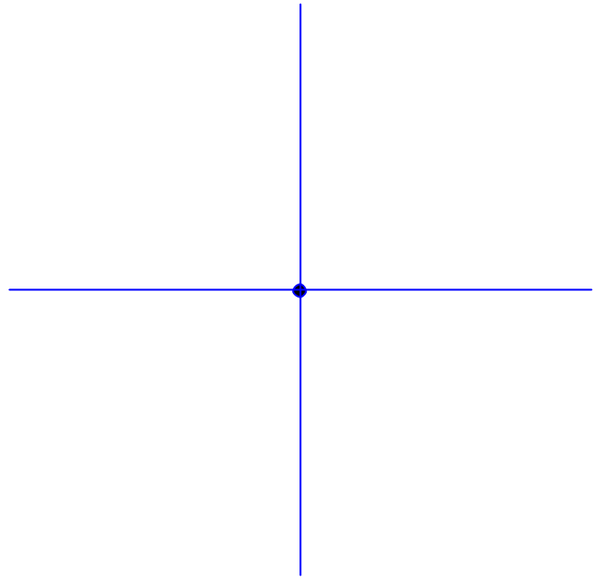
Transportation Example

Large Scale (TSSDS)
<= 1:24000



- Road Area
- Driveway Area
- Shoulder Area
- Sidewalk Area
- Curb

Small Scale (FGDC Transportation Subcommittee)
>= 1:24000



- Road Centerline
- Nodal Endpoint

CADD/GIS/FM Standards for Facilities, Infrastructure, & Environment (FIE) Data Model

(Option 2 Concept for incorporation of "transactional" FMSFIE with SDSFIE & A/E/C Standards. Development of FMSFIE Entity Sets began in Fiscal Year 2001)